(12) UK Patent Application (19) GB (11) 2 300 789 (13) A

(43) Date of A Publication 13.11.1996

(21) Application No 9509656.6

(22) Date of Filing 12.05.1995

(71) Applicant(s)
General DataComm Advanced Research Centre Limited

(Incorporated in the United Kingdom)

3 Olympic Business Centre, Paycocke Road, BASILDON, Essex, SS14 3EX, United Kingdom

(72) Inventor(s)
Richard Barnett

(74) Agent and/or Address for Service
Loven & Co
Claxlete House, 62 Clasketgate, LINCOLN, LN2 1JZ, United Kingdom

(51) INT CL[6]
H04L 7/00

(52) UK CL (Edition O)
H4P PSX

(56) Documents Cited
WO 95/05039 A1

(58) Field of Search
UK CL (Edition N) H4D DAB DD DPBC, H4P PPS PSB PSX
INT CL[6] G01S 5/14, H04B 7/00, H04L 7/00
Online:WPI

(54) Transmission time measurement in data networks

(57) A data network comprises a first and a second location, transmitting means at the first location for transmitting a data item including a time-stamp corresponding to the time of transmission of the item and receiving means at the second location for receiving the data item, for reading the time-stamp and for calculating therefrom and from the current time the time elapsed between transmission and receipt of the data item, characterised in that each location comprises a Global Positioning System receiver 12 for providing a synchronised time signal to the transmitting or receiving means.

The invention also provides a method of measuring data transit time between two locations in a data network particularly an ATM network.

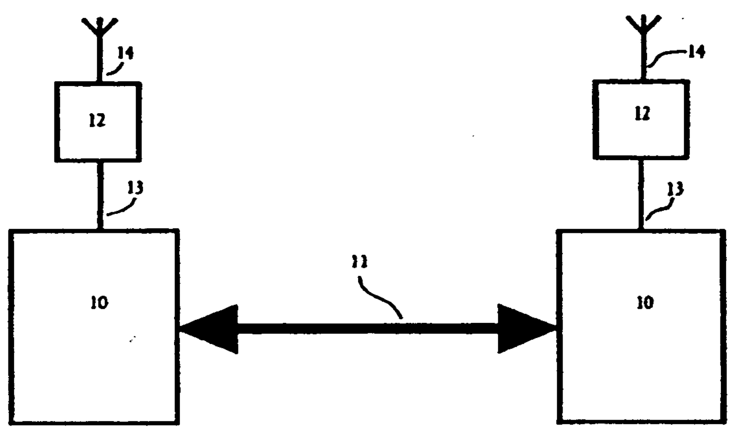

Fig 1

GB 2 300 789 A

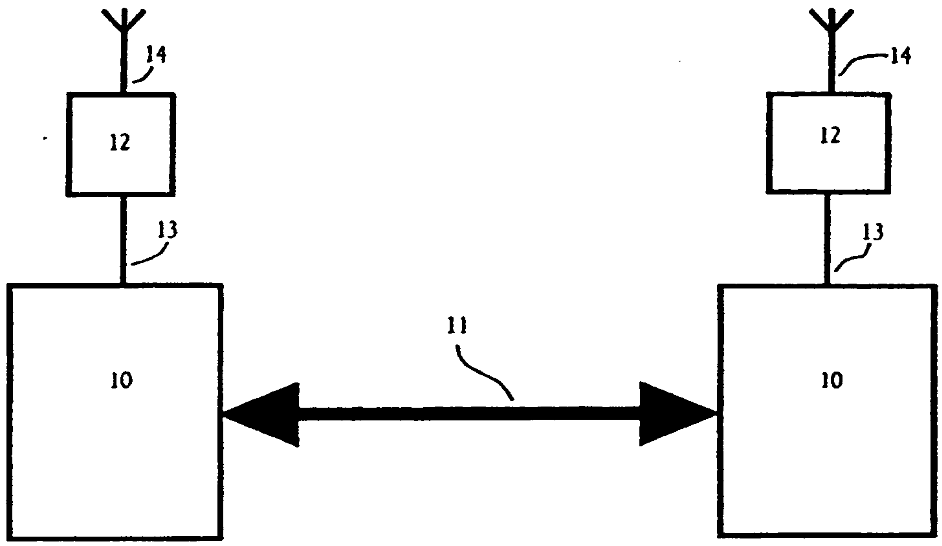

Fig 1

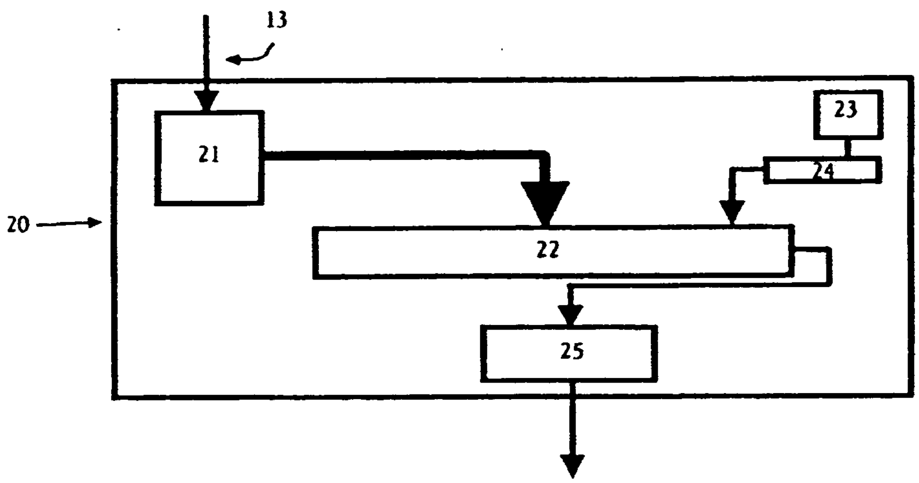

Fig 2

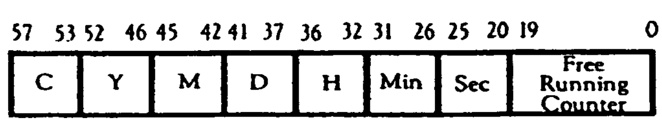

Fig 3

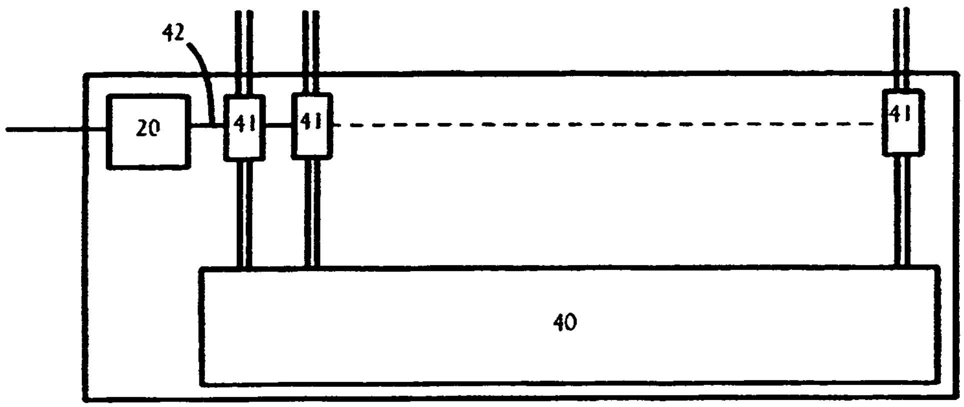

Fig 4

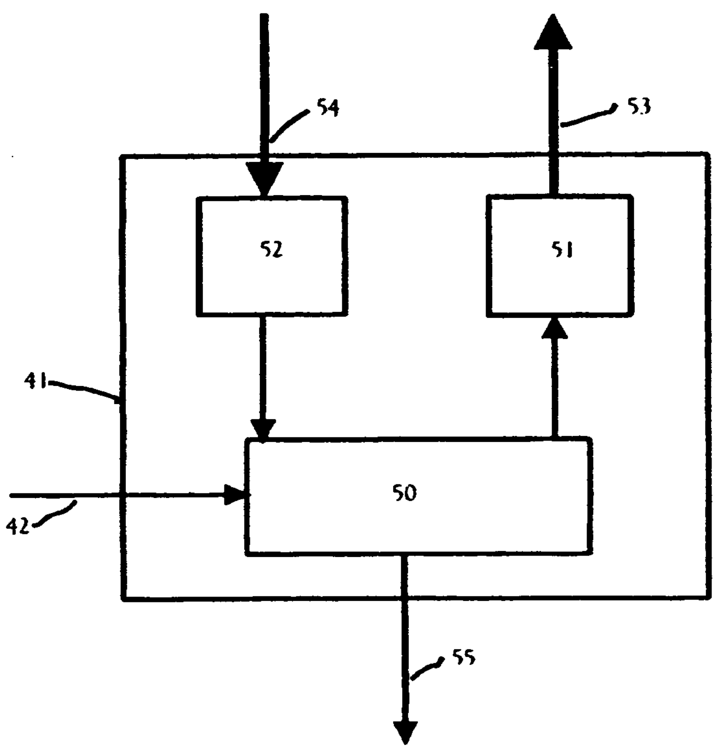

Fig 5

2300789

DATA NETWORK

Field of the Invention

This invention relates to a data network, and in particular to a data network including means for determining the time taken by a data item to travel between two points in the network. The invention is especially, but not exclusively, applicable to Asynchronous Transfer Mode (ATM) networks.

Background to the Invention

A critical quality of service parameter for ATM networks is the Cell Transit Delay (CTD) and its associated Cell transit Delay Variation (CDV). Unfortunately, it is extremely difficult to measure these parameters in real ATM networks, as measurement requires synchronised clocks at the points between which the cell CTD is to be measured, and these points will typically be geographically widely separated.

One solution which has been proposed for this problem is to send a cell from the measurement point and to loop it back from the end point to the measurement point again. The original cell contains a time-stamp indicating the time at which the cell was transmitted so that, when the cell is received again, the time-stamp can be subtracted from the current time. This gives the Round Trip Time (RTT) for the path at that particular moment. The problem is that the RTT is not the same as the CTD. If the traffic were symmetrical in each direction of transfer between the two measurement points, and with equal congestion levels, the CTD could be obtained from the RTT simply by dividing by 2. In reality, the traffic is not normally symmetrical and congestion levels are not the same in both directions at any given time.

Summary of the Invention

According to the invention, there is provided a data network comprising a first and a second location, transmitting means at the first location for transmitting a data item including a time-stamp corresponding to the time of transmission of the item and receiving means at the second location for receiving the data item, for reading the time-stamp and for calculating therefrom and from the current time the time elapsed between transmission and receipt of the data item, characterised in that each location comprises a Global Positioning System receiver for providing a synchronised time signal to the transmitting or receiving means.

The data network is preferably an ATM network, the first and second locations each comprising a data switch, for example of the type disclosed and claimed in our earlier UK Patent Applications Nos 9225480.4, 9321165.4 and 9505358.3.

Preferably both locations include the transmitting and receiving means to permit the time interval to be measured in either direction.

The invention also provides a method of measuring data transit time between two locations in a data network, comprising:

determining at a first of the locations an absolute time by means of a Global Positioning System receiver;

generating at the first location a performance measuring data item including a time stamp corresponding to said absolute time;

transmitting the data item to the second location;

receiving the data item at the second location and reading therefrom the time stamp;

determining at the second location by means of another Global Positioning System receiver an absolute time value for the arrival of the data item; and

subtracting the time stamp from the arrival time to give a transit time for the data item between the two locations.

The Global Positioning System (GPS) is a system using a plurality of satellites circling the earth, the receivers being arranged to receive transmissions from several of the satellites at the same time to determine their locations in three dimensions and also to determine very accurately the GPS time which has a fixed relationship to UTC (Universal Time Coordinated). Each receiver requires an aerial or antenna with a clear view of the sky. In order to provide an accurate time, the GPS requires that four satellites must be visible to a receiver. The numbers are such that, normally, at least four satellites will be visible to any receiver. Although the network of the invention uses the GPS to give an accurately synchronised time for the determination of data transit times across the network, the ability of the GPS receiver to give an accurately-determined location for the receiver means that any of the locations could use this data to create a network diagram, for example.

GPS receivers, for example the receiver sold under the trade mark Oncore by Motorola Inc., are arranged to output a one pulse per second time signal with a pulse leading-edge accuracy of 130ns, in addition to a time-of-day output and the location data. The former two outputs are used in the network of the invention to provide clocks at network nodes remote from each other sufficiently accurately synchronised to permit accurate measurement of the CTD and CDV in an ATM network, for example.

The system of the invention allows accurate measurements of CTD in ATM networks using standard Performance Management cells. User cells are not affected by these measurements, so they can be carried out on a routine basis in normal operation.

Brief Description of the Drawings

In the drawings, which illustrate diagrammatically part of an ATM network in accordance with an exemplary embodiment of the invention:

Figure 1 illustrates two ATM network switches between which CTD and CDV are to be measured;

Figure 2 represents the system controller (SYSCON) in one of the switches;

Figure 3 represents the time register forming part of the SYSCON shown in Figure 2;

Figure 4 illustrates in more detail one of the network switches of Figure 1; and

Figure 5 illustrates one of the slot controllers from the network switch of Figure 4.

Detailed Description of the Illustrated Embodiment

Referring to Figure 1, the two switches 10 form parts of a more extensive ATM network, with the network data links between the switches being represented by the arrowed line 11. Each switch is provided with a GPS receiver 12, for example of the type sold by Motorola Inc under the trade mark Oncore. Each receiver 12 is linked to its respective switch 10 by means of an RS-232 serial link 13, the switch being provided with a UART-based interface as hereinafter described with reference to Figure 2. Each GPS receiver 12 has its own antenna 14 located in such a position as to have a clear "view" of the sky.

Figure 2 shows the system controller or SYSCON 20 in one of the switches 10. The SYSCON 20 includes the RS-232 interface 21 to which the serial link 13 is connected. The interface 21 passes to a time register 22 the time data from the GPS receiver, together with a 1 PPS (1 Pulse Per Second) signal also output by the receiver. The time register 22 has a 625 kHz input derived from an accurate 10

MHz oscillator 23 in the SYSCON 20 via a divide by sixteen counter 24. The operation of the time register is described further with reference to Figure 3, but its output is an accurate time distributed by output means 25 to all the slot controllers in the switch every four cell internal times (2.56μs).

Figure 3 shows the format of the time register. This is a 58-bit register that contains the time and date obtained from the GPS receiver, and a running count. The least significant 20 bits are the outputs of a free-running counter being clocked at a very accurate 625kHz, derived as hereinbefore described. The 10MHz oscillator used gives an accuracy or +/− 4.6 ppm, which determines the accuracy of the CTD measurements that are obtained. The free-running counter is reset by the rising edge of the 1 PPS signal. The counter is arranged so that it can be forced to all 1s if the GPS receiver is not operating.

The next 6 bits consist of a modulo 60 time measurement seconds register. This is set by software every second to reflect the seconds value obtained from the GPS receiver. It is also incremented by the 1 PPS rising edge. This guarantees that the counter is incremented as the running counter is reset and that the value of the counter is correct. This counter can also be forced to all 1s if the GPS receiver is not operating. The remaining 32 bits contain the remainder of the time and date. 6 bits are used for the minutes, 5 bits are used for the hours (H), 5 bits are used for the days (D), 4 bits are used for the months (M), and 12 bits are used for the year (C & Y). These 32 bits are loaded by the software every second to ensure that they are correct.

Figure 4 shows in simple form a typical ATM switch 10 having a switch fabric, for example in the form of a crosspoint structure 40, with sixteen slot controllers 41 linked thereto, each with an input and an output connection to the switch fabric 40 and with an input and output connection to an external data link, for

example to another such switch at a location remote therefrom. The SYSCON 20 is linked to all the slot controllers 41, for example by an Ethernet control network 42 within the switch, and transmits the 58-bit time information every 4 cell internal cell times, as hereinbefore described. As may be seen from Figure 5, each slot controller 41 comprises an OAM (Operations And Management) controller 50 to generate special Performance Management (PM) cells for use in the monitoring of network performance. Under ATM Forum specifications, such cells have an optional 32-bit Time Stamp (TS) field, and the OAM controller 50 transfers the least significant 32 bits of the 58-bit absolute time value transmitted by the SYSCON 20 to this TS field. These 32 bits contain the free-running counter value, the seconds and the minutes. The slot controller comprises cell transmitting control means 51 and cell receiving control means 52, connected respectively to the output 53 and input 54 lines of the external data link to the slot controller.

In use, under control of a network management system, the OAM controller 50 adds the current time value to the TS filed of a PM cell, and this is then sent by the transmitting control means 51 over the network to the destination switch, in which a similarly-configured slot controller receives the PM cell on its input line 54, and the receiving control means 52 passes the cell to the OAM controller 50, where the TS value in the cell is read out and subtracted from the current time value to give an absolute time difference. This difference value is then passed via line 55 to the network management system, the figure either being used locally or being transmitted back to the source switch for use there.

The basic time accuracy of the 1 PPS output of the GPS receiver is 130ns. However, the error in the measurement system is up to 11.76μs. This comes from the 4.6ppm error in the oscillators at each end causing a total of 9.2μs error in the one second free running counter period plus the worst-case error caused by the fact

that the absolute time is only sent to the slot controllers once every four internal cell times (2.56μs). However, since the minimum delay through an ATM switch is generally more than this, the system of the invention is accurate enough to detect the number of switches in a path (in the worst case where they are lightly loaded). This is the maximum accuracy needed for CTD measurements.

CLAIMS

1. A data network comprising a first and a second location, transmitting means at the first location for transmitting a data item including a time-stamp corresponding to the time of transmission of the item and receiving means at the second location for receiving the data item, for reading the time-stamp and for calculating therefrom and from the current time the time elapsed between transmission and receipt of the data item, characterised in that each location comprises a Global Positioning System receiver for providing a synchronised time signal to the transmitting or receiving means.

2. A data network according to Claim 1, which is an Asynchronous Transfer Mode (ATM) network and the data item is an ATM cell.

3. A data network according to Claim 1 or 2, wherein both locations include the transmitting and receiving means to permit the time interval to be measured in either direction.

4. A data network, substantially as described with reference to, or as shown in, the drawings.

5. A method of measuring data transit time between two locations in a data network, comprising:

determining at a first of the locations an absolute time by means of a Global Positioning System receiver;

generating at the first location a performance measuring data item including a time stamp corresponding to said absolute time;

transmitting the data item to the second location;

receiving the data item at the second location and reading therefrom the time stamp;

determining at the second location by means of another Global Positioning System receiver an absolute time value for the arrival of the data item; and

subtracting the time stamp from the arrival time to give a transit time for the data item between the two locations.

6. A method according to Claim 6, wherein the data network is an ATM network and the data item is an ATM cell.

7. A method of measuring data transit time between two locations in a data network, substantially as described with reference to the drawings.

Amended claims have been filed as follows

1. An ATM data network comprising a first and a second location, transmitting means at the first location for transmitting an ATM cell including a time-stamp corresponding to the time of transmission of the cell and receiving means at the second location for receiving the cell, for reading the time-stamp and for calculating therefrom and from the current time the time elapsed between transmission and receipt of the cell, characterised in that each location comprises a Global Positioning System receiver for providing a synchronised time signal to the transmitting or receiving means.

2. An ATM data network according to Claim 1, wherein both locations include the transmitting and receiving means to permit the time interval to be measured in either direction.

3. An ATM data network, substantially as described with reference to, or as shown in, the drawings.

4. A method of measuring Cell Transmit Delay between two locations in an ATM data network, comprising:

determining at a first of the locations an absolute time by means of a Global Positioning System receiver;

generating at the first location a performance measuring ATM cell including a time stamp corresponding to said absolute time;

transmitting the cell to the second location;

receiving the cell at the second location and reading therefrom the time stamp;

determining at the second location by means of another Global Positioning System receiver an absolute time value for the arrival of the cell; and

subtracting the time stamp from the arrival time to give a Cell Transmit Delay for the cell between the two locations.

5. A method of measuring data transit time between two locations in an ATM data network, substantially as described with reference to the drawings.

12

Patents Act 1977 **Examiner's report to the Comptroller under Section 17** **(The Search report)**	Application number GB 9509656.6
Relevant Technical Fields (i) UK Cl (Ed.N) H4P PSX, PPS, PSB; H4D DPBC, DAB, DD (ii) Int Cl (Ed.6) H04L 7/00; G01S 5/14; H04B 7/00	Search Examiner MR J P COULES Date of completion of Search 11 JULY 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- 1-7

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
X	WO 95/05039 A1 (GLENAYRE ELECTRONICS) See whole document.	1 and 5

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).